

## EFFECTS OF ORAL SODIUM BICARBONATE SUPPLEMENTATION ON NUTRITIONAL STATUS OF PATIENTS UNDERGOING MAINTENANCE HEMODIALYSIS

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**Abstract** To determine the oral sodium bicarbonate supplementation effects on nutritional status of patients undergoing maintenance hemodialysis. In a Medicine department at Combined Military Hospital, Peshawar, a case-control study was carried on "14-October 2021 to 14-April 2022". It enrolled patients of ESRD on MHD with low serum bicarbonate levels. Patients were allocated into two groups: an experimental group receiving oral sodium bicarbonate and a control group receiving standard care. Parameters such as mid-thigh circumference, serum bicarbonate, and serum albumin were assessed at baseline and after 3 months, with statistical analysis performed using an independent sample t-test. The intervention group had a notable elevation in serum bicarbonate levels ( $20.87 \pm 1.58$  mmol/l) as compared to the control group ( $18.73 \pm 2.38$  mmol/l) ( $P = 0.0001$ ). Furthermore, it was observed that the intervention group had a noteworthy elevation in serum albumin levels after 3 months ( $4.40 \pm 0.28$  g/l), as compared to the control group ( $3.77 \pm 0.30$  g/l) ( $P = 0.0001$ ). Additionally, there was a statistically significant rise in the average mid-thigh circumference among participants in the intervention group during the third month, in comparison to those of the control group ( $41.20 \pm 1.70$  vs.  $39.74 \pm 1.27$  cm;  $P = 0.001$ ). Oral sodium bicarbonate supplementation in patients on maintenance hemodialysis significantly increased serum bicarbonate level, serum albumin level and mid-thigh size.

**Keywords:** Chronic kidney Disease, Hemodialysis, Sodium bicarbonate

### Introduction

Chronic kidney disease (CKD) is a global health concern globe, affecting a huge population and imposing a substantial choking effect on healthcare systems worldwide (Bikboy et al., 2018). Among the various treatment modalities for CKD, maintenance hemodialysis (HD) is a life-sustaining treatment among end-stage renal disease (ESRD) patients (Wiliyanarti and Muhith, 2019). However, patients undergoing HD often face numerous complications, including metabolic acidosis, malnutrition, and muscle wasting, significantly impacting their nutritional status and overall well-being (Sabatino et al., 2017). Sodium bicarbonate, a commonly used agent to manage metabolic acidosis, has emerged as a potential therapeutic intervention to address these challenges (Kourtellidou et al., 2021; Di Iorio et al., 2019). Nutritional status is a vital aspect of the overall health and quality of life for patients with ESRD undergoing HD. However, this population is particularly susceptible to malnutrition and protein-energy wasting, which are linked to various adverse outcomes, including increased morbidity and mortality (Bakaloudi et al., 2020). Metabolic acidosis is a common complication in HD patients, arising from the accumulation of acidic waste

products due to impaired renal function<sup>8</sup>. This condition disrupts acid-base balance and contributes to muscle catabolism, bone demineralization, and decreased protein synthesis. As metabolic acidosis worsens, the nutritional status of HD patients deteriorates, potentially leading to profound muscle loss, malnutrition, and frailty (Sofia et al., 2005; Copur et al., 2020).

Numerous clinical studies have explored the significance of oral sodium bicarbonate supplementation in patients on hemodialysis. These investigations have assessed various parameters, and preliminary findings suggest that sodium bicarbonate supplementation may positively impact these outcomes (Aigner et al., 2019; de Brito et al., 2009).<sup>11</sup> Sodium bicarbonate, a simple and cost-effective intervention, has garnered interest as a potential tool to address metabolic acidosis and its associated nutritional consequences in HD patients. By correcting acidosis, sodium bicarbonate supplementation aims to improve protein synthesis, reduce muscle catabolism, and enhance appetite, ultimately promoting better nutritional status. This study aims to determine the effects of oral sodium bicarbonate supplementation on the nutritional status

of patients undergoing maintenance hemodialysis. Research in this area seeks to elucidate whether this intervention can mitigate the dietary challenges that HD patients commonly face.

**Material and methods**

In 14-October 2021, we initiated a case-control study within the medicine department of Combined Military Hospital, Peshawar, which continued till 14-April 2022". The study focused on consenting ESRD patients undergoing MHD with the following inclusion criteria: serum bicarbonate levels < 24 mmol/L, dialysate bicarbonate levels of 35 mmol/L, absence of residual renal function (defined as 24-hour urine output less than 200 ml), utilization of arteriovenous fistulae as the dialysis access, maintenance of a stable clinical condition, and a willingness to provide written informed consent. Critically ill patients, bedridden patients, and individuals with a limited life expectancy were excluded from the study.

The enrolled patients underwent three weekly dialysis sessions, each lasting 4 hours, utilizing a Baxter Polyflux 21 dialyzer. The dialysis blood flow rate (Qb) ranged (230 - 300 ml/min). However, the dialysate flow rate (Qd) ranged (550 - 750 ml/min). Patients were assigned into two groups: i.e Interventional and control groups. Patients in the interventional group received a fixed daily dosage of 500 mg of oral sodium bicarbonate tablets. Adherence to the prescribed sodium bicarbonate dose was assessed by a specialized pharmacist who supervised medication records, oral capsule usage, and any drug-associated adverse effects. In contrast, the control group received standard care without sodium bicarbonate supplementation. Key parameters, including mid-thigh circumference (MTC), serum bicarbonate levels, and serum

albumin levels, were evaluated and compared between the two groups at the study's outset and the conclusion of the 3-month intervention period. The final analysis was performed according to the standard protocol analysis approach. Independent sample t-test was employed to evaluate the mean differences between the two groups, with significance as a p-value < 0.05.

**Results and discussions**

This case-control study encompassed a cohort of 50 patients undergoing maintenance hemodialysis. In the interventional group, the mean age was 50.84±11.43 years, whereas the control group had a mean age of 48.16±11.43 years. The intervention group comprised 72% male and 28% female patients, whereas the control group comprised 68% male and 32% female patients. Additionally, 20% of the intervention and 28% of the control groups had diabetes. Table 1 summarizes baseline outcome parameters, including mean serum bicarbonate levels, serum albumin levels, and mid-thigh circumference, revealing no significant differences between the two groups at baseline. Table 2 presents the comparison of outcome variables in the 3rd month, demonstrating a noteworthy increase in serum bicarbonate levels within the intervention group (20.87±1.58 mmol/l) compared to the control group (18.73±2.38 mmol/l) (P = 0.0001). Moreover, serum albumin levels in the intervention group exhibited a significant increase in the 3rd month (4.40±0.28 g/l) in comparison to the control group (3.77±0.30 g/l) (P = 0.0001). Furthermore, there was a significant increase in the mean mid-thigh circumference at the 3rd month in the intervention group compared to the control group (41.20±1.70 vs. 39.74±1.27 cm; P = 0.001).

**Table 1 Outcome parameters at baseline**

Groups		Serum bicarbonate (mmol/l) at baseline	Serum albumin level (g/l) at baseline	Mid-Thigh Circumference (cm) at baseline
Intervention	Mean	17.4652	3.5872	37.6800
	N	25	25	25
	Std. Deviation	2.21037	.38780	1.02405
Control	Mean	17.5192	3.4992	38.0300
	N	25	25	25
	Std. Deviation	1.37400	.30823	1.02465
P value		0.91	0.37	0.23

**Table 2 Comparison of outcome parameters at 3<sup>rd</sup> month**

	Groups	N	Mean	Std. Deviation	P value
Serum bicarbonate (mmol/l) at three months	Intervention	25	20.8776	1.58155	0.0001
	Control	25	18.7344	2.38476	
Serum albumin level (g/l) at three months	Intervention	25	4.4072	.28864	0.0001
	Control	25	3.7716	.30332	
Mid Thigh	Intervention	25	41.2060	1.70840	0.001

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Circumference (cm) at three months	Control	25	39.7480	1.27981	
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The periodicity of hemodialysis (HD) leads to the buildup of uremic toxins between dialysis sessions, followed by their swift elimination during the dialysis procedure, causing a fluctuating or "saw-toothed" pattern for specific uremic toxins. It is worth mentioning that there is a tendency for unfavorable outcomes, such as cases of mortality, such as sudden death, to occur in close proximity to dialysis sessions. Strategies focused on reducing the saw-toothed toxin profile are beneficial in promoting optimal dialysis outcomes, as evidenced by the growing prevalence of hemodialysis (Bleyer et al., 2006).

Uremic toxins, characterized by a closely aligned saw-toothed pattern, comprise electrolytes like potassium. These toxins are significantly related to peri-dialytic morbidity and mortality based on feasible and statistically significant evidence. Acidosis exhibits a comparable inverse trend, wherein there is a steady decrease in bicarbonate levels over the inter-dialytic period, succeeded by a swift re-establishment during dialysis (Brunelli et al., 2017). Empirical investigations focusing on clinical outcomes provide evidence to support the assertion that acidosis has negative consequences. Upon considering the presence of comorbidities, it has been established that there exists a correlation between pre-dialysis bicarbonate levels < 22 mmol/L and an elevated mortality rate. Acidosis often plays a significant role in peri-dialytic adverse events, potentially worsening the rise in plasma potassium levels and causing negative effects over a longer period. These effects may include increased muscle breakdown due to impaired insulin signaling, and insulin-like growth factor-1, ultimately resulting in muscle protein catabolism. The existing data on the correlation between acidosis and diminished muscle strength present conflicting results. A substantial study conducted on a group of older individuals demonstrated positive connections between the two variables. However, a smaller preliminary study focusing on individuals with moderate to advanced kidney disease and their use of bicarbonate supplementation reported contradictory findings. It is worth noting that there is a paucity of research investigating the potential correlation between acidosis and handgrip strength in patients who are undergoing hemodialysis (HD) (Abramowitz et al., 2011). Research studies investigating the management of acidosis in persons receiving hemodialysis typically focus on dialytic supplements. This approach involves the rapid correction of bicarbonate levels during dialysis sessions and the slow buildup of acidosis between these sessions. However, if orally delivered

throughout the inter-dialytic period, uraemic acidosis has the potential to be consistently improved, which sometime leads to a reduction in both short-term and long-term negative outcomes related to dialysis (Abramowitz et al., 2013; Basile et al., 2018; Jo et al., 2017).

We conducted this case-control study on 50 CKD patients undergoing maintenance hemodialysis. Patients were equally divided into two groups i.e: the interventional and the control groups. At baseline the mean serum bicarbonate levels in the intervention group were  $17.46 \pm 2.21$  mmol/l, while in the control group it was  $17.51 \pm 1.37$  mmol/l. When the serum bicarbonate levels were assessed after three months we observed that in the interventional group the levels considerably increased compared to the control group ( $20.87 \pm 1.58$  vs  $18.73 \pm 2.38$  mmol/l;  $P = 0.0001$ ). A study reported a significant increase in serum bicarbonate levels in the intervention group after sodium bicarbonate therapy.<sup>17</sup> We observed a significant difference in serum albumin levels between both groups as well, in the intervention group, the serum albumin levels significantly increased after 3 months in comparison to the control group ( $4.40 \pm 0.28$  and  $3.77 \pm 0.30$  g/l;  $P = 0.0001$ ), similar reports have been demonstrated by a study which showed that serum albumin significantly increased in the interventional group after sodium bicarbonate therapy in hemodialysis maintenance patients (Rasheed et al., 2023). Similarly we observed a significant increase in mid-thigh size in the interventional group compared to the control group ( $41.20 \pm 1.70$  vs  $39.74 \pm 1.27$  cm;  $P = 0.001$ ) which agrees with a study reporting the same findings (Lamsal, 2020).

### Conclusion

From our study, we conclude that Oral sodium bicarbonate supplementation among patients on maintenance hemodialysis significantly increased serum bicarbonate level, serum albumin level, and mid-thigh size. We safely assume that oral sodium bicarbonate gradually slows down the progression of kidney disease.

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#### Declarations

#### Data Availability statement

All data generated or analyzed during the study are included in the manuscript.

#### Ethics approval and consent to participate

Not applicable

#### Consent for publication

Not applicable

#### Funding

Not applicable

#### Conflict of Interest

Regarding conflicts of interest, the authors state that their research was carried out independently without any affiliations or financial ties that could raise concerns about biases.



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